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NASA TT F-8138

DRAFT TRANSLATION

JAN 1 5 1962
X63-11480
code-2d

MAGNETIC STORM EFFECTS ON COSMIC RAYS IN THE SOLAR ACTIVITY MINIMUM

(Effekty magnitnykh bur' v kosmicheskikh luchakh v minimume solnechnoy aktivnosti)

Geomagnetizm i Aeronomiya
Tom I, No. 5, pp. 839-841
Izd-vo A. N. SSSR,
Moskva, 1961.

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The lowering of cosmic ray intensity during magnetic storms (Forbush effect) presents a great interest for an effective investigation of electromagnetic properties of solar corpuscular streams. A detailed investigation of Forbush effects was conducted according to data of world station network during the IGY and the IGC, i.e. for the epoch of solar activity maximum. It was then demonstrated, among other things, that solar plasma is substantially compressed in the leading edge of solar corpuscular streams, while the magnetic field is correspondingly intensified [1]. The formation of such a magnetic cushion may be linked with the presence of a sufficiently dense interplanetary medium ($10 - 10^2$ cm^{-3}), whose interaction with the solar corpuscular stream precisely leads to the flux' plasma compression. Properties of the interplanetary medium, of solar corsuscular streams, and the general state of the interplanetary medium may be subject to changes with the variation of solar activity. Thus, data on Forbush effects must necessarily offer a great interest in connection with the above during solar activity minimum.

Analysis of Forbush effects for the period 1953-1955 is given below according to Tbilisi observation data with the aid of a shielded ionization chamber

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Data on Magnetic Storms. These were taken from observations at the Dusheti magnetic observatory [2]. 103 storms were registered during the period 1953-1955, of which 92 were utilized in the analysis. They were broken down into the following groups :

1. Major storms with a sudden commencement (3).
2. Major storms with a gradual commencement (3).
3. Moderate storms with a sudden commencement (4).
4. Moderate storms with a gradual commencement (22).
5. Minor storms with a sudden commencement (8).
6. Minor storms with a gradual commencement (52).

During the period of the deepest solar activity minimum (October 1953 to October 1954), not a single major storm was observed Neither were observed moderate or minor storms with sudden commencement.

Data on Cosmic Rays. Data on time variations of cosmic rays' hard component were obtained with the aid of a shielded ionization chamber installed in a space covered with a plating of not more than 10 10 g/cm^2 thickness. The continuous registration began on 15 March 1953 and extended through 1956. Data for the indicated period were corrected for the ionization bursts and barometric effects.

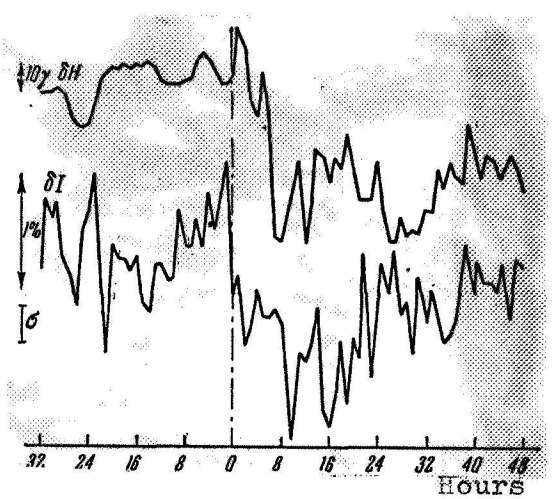

Fig. 1

Let us bring forth the results of analysis of six groups of storms :

1st Group. Plotted are in Fig. 1 data on cosmic rays obtained by the method of epoch superimposition (hours of magnetic storm commencement were taken for zero hours) for three storms of the 1st type. Here are also brought forth data on H- component variation obtained by the same method. A Forbush effect, whose mean amplitude represents near 1.5 - 2 percent, is visible. Noted also is an ascending effect prior to the commencement

of magnetic storms, whose nature is linked, according to [4, 5], with the reflection of cosmic ray particles from the magnetized leading edge of the corpuscular stream, counter-currently moving toward them. The total duration of the Forbush effect is nearly 2 days. The graph presented points to a certain advance of the Forbush effect commencement relatively to the commencement of the magnetic storm. However, this result entails a further research over larger material.

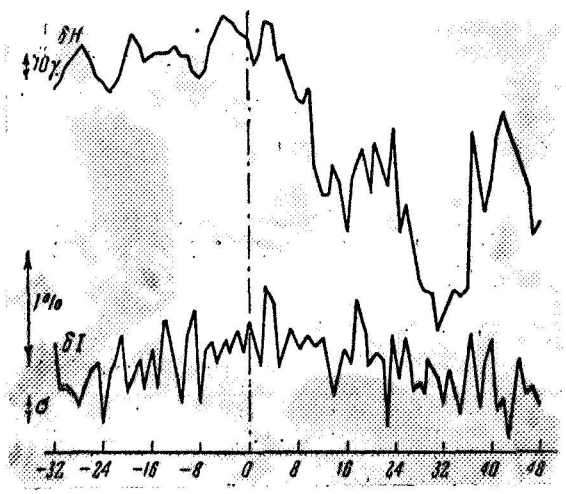

Fig. 2

The comparison of H-component's variations and cosmic ray intensity shows that there is a close negative correlation between these two curves, particularly well expressed from 8 00 to 12 — 16 00 hours after the magnetic storm's commencement. We assume that this variation is basically linked with the variation of the "edging " hardness on account of the perturbation of the geomagnetic field in the vicinity of the Earth. [6, 7].

2nd Group. The results of analysis of this group (major storms with gradual commencement) are plotted in Fig. 2. The H-component indicates variations similar to those of the storms of the 1st Group, but the intensity of cosmic rays does not reveal notable variations, in excess of 0.2 — 0.3 percent, although a certain trend toward a smooth decrease of about 0.3 percent for a 2-day period is noted. It is not excluded that part of the decrease may be compensated by the increase connected with the geomagnetic field decrease.

Groups 3 & 4. In this case (Fig. 3) what is observed is not the decrease in intensity, but rather a small increase linked with a geomagnetic field decrease, and a corresponding decrease in hardness. A similar pattern is observed for the group IV.

Groups 5 and 6. The results of analysis show, that within the bounds of statistical fluctuations (0.1%), minor magnetic storms do not exert any influence on cosmic ray intensity. This agrees well with the data for solar activity maximum.

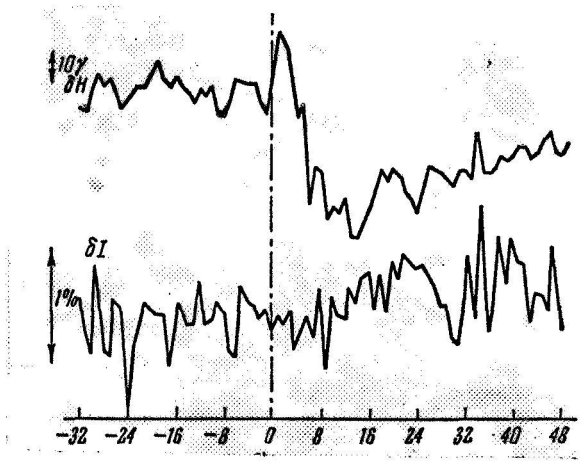

Fig. 3.

The analysis of the effects on cosmic rays of magnetic storms of various intensities with different commencements allows the reaching of the following conclusions:

1. Forbush effect is only noted for major storms with sudden commencement. Hence, it follows, that the corpuscular streams generating these storms, bear frozen magnetic fields that are sufficiently expanded and have a great intensity. These fields scatter effectively cosmic rays with energies of tens of BeV.

2. For major storms with a sudden commencement there apparently also takes place a rising effect prior to storm commencement. This shows that corpuscular streams, having generated the storm in solar activity minimum, are magnetized, and that a magnetic cushion has formed in their forward part (leading edge).

3. The character of corpuscular streams' interaction with the geomagnetic field does not vary substantially in the solar activity minimum, inasmuch as the "edging" hardness variation has the same character as in solar activity maximum.

Inasmuch as these conclusions are based upon observation data from only one station, they must be regarded as preliminary.

The author takes this opportunity to express his gratitude to N. A. Katsiashvili for making available the materials of the Dusheti catalog.

*** END ***

Translated by ANDRE L. BRICHANT
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on 14 January 1962.

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Entered on 4 July 1961.

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